PROCEEDINGS

OF

THE ROYAL SOCIETY.

1838. No. 34.

June 21, 1838.

FRANCIS BAILY, Esq., V.P. and Treas., in the Chair.

The Treasurer announced from the Chair that a deputation of the Society, consisting of His Royal Highness the President, the Vice-Presidents, Treasurer, Secretaries, and other Members of the Council, waited yesterday on *Her Majesty*, for the purpose of receiving *Her Majesty's* signature in the Charter-book of the Society, as Patroness of the Royal Society, when *Her Majesty* was graciously pleased to inscribe her name accordingly; on which occasion His Royal Highness made the following address:

"MAY IT PLEASE YOUR MAJESTY,

"IN obedience to your gracious Commands, the President and the Council of the Royal Society for the promotion of Natural Knowledge now appear in your Royal presence, humbly to tender the register of its Members for the insertion of your august signature.

"Our very name and the recollection of our first institution prompt and encourage us to look up to Your Majesty as our Patron and Protector; and which, by this especial act of your favour, will confirm to the Society the assurance so graciously communicated to us, in your name, by the Secretary of State for the Home Department, in reply to the dutiful Address we had the honour to present to your Majesty on your accession.

"Permit me, Most Gracious Sovereign, to avail myself of this opportunity to express to your Majesty, in the name and on the behalf of the Fellows of the Royal Society, their gratitude for your munificent grant of two Gold Medals annually, for the encouragement of Science in its different branches; and more especially for allowing the Council so to alter for the present year the statute regulating the distribution of them, as to render it available and conformable to the view for which it was framed.

"Peace, Navigation and Commerce, are as necessary to the growth of Literature, as to the intercourse with the Natural World.

"Of these blessings we were already in possession when Your Majesty ascended the Throne of your Ancestors. That such may continue to exist and thrive in this happy country during a long, prosperous, and useful reign, with every other earthly felicity which Divine Providence in its wisdom may deign to shower down on Your Royal and Sacred Head—is the most ardent wish and fervent prayer of the President, Council, and Fellows of the Royal Society, in unison with all your other loyal subjects."

The following papers were then read, viz.

"On the structure of the teeth, the vascularity of those organs, and their relation to bone." By John Tomes, Esq. Communicated by Thomas Bell, Esq., F.R.S., Professor of Zoology in King's College, London.

The microscopical examinations which the author has made of the structure of the teeth of man and various animals, lead him to the conclusion that their bony portions are formed of minute tubes, disposed in a radiated arrangement, in lines proceeding everywhere perpendicularly from the inner surface of the cavity containing the pulp. These tubuli are surrounded by a transparent material, which cements them together into a solid and dense mass. He finds, by applying the test of muriatic acid, that carbonate as well as phosphate of lime enters into their composition. In man, the tubuli, during their divergence from their origin at the surface of the central cavity, send off a number of very minute fibrils; and on approaching the enamel or the granular substance, which cover respectively the crown and the fangs of the tooth, the tubuli divide into smaller ones, which freely anastomose with one another, and then either are continued into the enamel, or terminate at the boundary between these two substances. Various modifications of this structure, exhibited in the teeth of different animals, in the class Mammalia and Fishes more particularly, are minutely described. The granular substance appears to be composed of irregularly shaped osseous granules, imbedded in the same kind of transparent medium which cements the tubuli together. External to the granular portion, the author finds another substance entering into the formation of the simple tooth, and commencing where the enamel terminates; and which he describes as beginning by a thin and transparent layer containing only a few dark fibres, which pass directly outwards; but assuming, as it proceeds towards the apex of the fang, greater thickness and opacity, and being traversed by vessels.

External to the enamel, and in close connexion with it, in compound teeth, is situated the crusta petrosa, a substance very similar to the bony layer of the simple tooth. It contains numerous corpuscles, and is traversed by numerous vessels entering it from without, and anastomosing freely with one another, but terminating in its substance. These investigations of the structure of the different component parts of teeth, furnish abundant evidence of their vascularity and consequent vitality.

"On the evolution of Nitrogen during the growth of plants, and the sources from whence they derive that element." By Robert Rigg Esq. Communicated by the Rev. J. B. Reade, M.A., F.R.S., &c.

In this communication the author follows up his inquiry into the influence and importance of nitrogen in vegetable physiology, by noticing, in the first place, the experiments of Dr. Daubeny, M. De Saussure, Sir Humphry Davy, and those which he himself has made; all of which tend to prove that nitrogen is evolved during the healthy performance of the functions of plants; that the proportion which it bears to the oxygen given off is influenced by the sun's rays; but that owing to the necessary exclusion of the external atmosphere during the progress of the experiments, it is impossible, with any degree of accuracy, to calculate the volume of these evolved gases during any period of the growth of plants in their natural state.

If to this indefinite quantity of nitrogen given off by plants there be added that definite volume incorporated into their substance and shown in the author's former tables, the question arises, whence do plants derive their nitrogen, and does any part of it proceed from the atmosphere? A problem which the author proposes to solve by a series of tabulated experiments upon seeds, and seedling plants, indicating a large excess of nitrogen in the latter, and under such circumstances of growth that he is compelled to fix upon the atmosphere as its source.

By the same mode of experimenting, the author attempts to show that the differences which we find in the germination of seeds and the growth of plants in the shade and sunshine, are apparently due in a great measure to the influence of nitrogen. And he concludes by observing, that he does not touch upon the practical application of the subject wherein the real value of the inquiry consists; it is his object to draw attention to an element which, though in some instances so minute in quantity as to be with difficulty detected in our balances, has nevertheless been wisely assigned to discharge the most important functions.

"On the decussation of fibres at the junction of the Medulla Spinalis with the Medulla Oblongata." By John Hilton, Esq. Communicated by P. M. Roget, M.D., Sec. R.S.

The author first alludes to what usually happens in affections of the brain, namely, that the loss of voluntary power and of sensation manifest themselves in the opposite side of the body to that in which the cerebral lesion exists, a fact which has been attempted to be explained by the crossing of the fibres at the junction of the *medulla oblongata* with the anterior or motor columns of the *medulla spinalis*; but such a structure, he observes, affords no explanation of the loss of sensation. The author then, referring to the communication of Sir Charles Bell to the Royal Society, in the year 1835, describing a decussation connected with the posterior columns, or columns of sensation, mentions that the accuracy of these dissections was doubted by Mr. Mayo and other eminent anatomists. The author proceeds to state that the symptoms of cerebral lesion do not always take place on the opposite side of the body to that in which the lesion of the brain exists, but that they occur sometimes on the same side; that the loss of power and of sensation, although confined to the same side, may exist in either the upper or the lower extremity;

but that both are not necessarily implicated; and that, in fact, cases occur where there are marked deviations from what may be considered the more common occurrence. Having observed such cases, and not being aware of any satisfactory explanation, the author examined with care the continuation upwards of the anterior and posterior columns of the spinal marrow into the *medulla oblongata* and found that the decussation at the upper part of the spinal marrow belonged in part to the columns for motion, and in part to the columns for sensation; and farther, that the decussation is only partial with respect to either of these columns; thus elucidating by the observation of the actual structure what before appeared very unsatisfactory in pathology, and anomalous in disease.

The paper is illustrated by drawings made from the dissections of the author.

"Description of a self-registering Thermometer and Barometer invented by the late James Coggan, Esq., and bequeathed by him to the Royal Society." By Roderick Impey Murchison, Esq., F.R.S., V.P.G.S., &c.

The self-registering thermometer used by Mr. Coggan is of Six's construction, and consists of a siphon tube, open at one extremity, and operating by the expansion and contraction of a large body of spirit pressing on a column of mercury in the lower bend of the tube. On the other side of the wooden frame to which this thermometer is fixed, a siphon barometer is attached; and both these instruments are made to act on iron-floats suspended by a thread, and counterpoised over a pulley. Transverse wires are affixed to these threads, and are forced against a sheet of ruled paper on a frame, which from its connexion with a clock is advanced a certain space each day, by a spring hammer forming part of the striking machinery of the clock.

"On the action of light upon the colour of the River Sponge." By John Hogg, M.A., F.L.S., C.P.S., &c., Fellow of St. Peter's College, Cambridge. Communicated by Thomas Bell, Esq., F.R.S.

The author found that the green colour of the *Spongilla fluviatilis*, or river sponge, is acquired solely through the agency of light, and is lost when the sponge is removed from its influence. As this does not appear to be the case with Actiniæ, the Hydra viridis, or any other Polype, the author is disposed to consider this production as being nearer allied to the Algæ or Fungi, than to any tribe belonging to the animal kingdom.

"Researches on the Tides. Ninth Series. On the deduction of the Laws of the Tides, from short Series of Observations." By the Rev. W. Whewell, M.A. Trin. Coll., Cambridge.

It is very desirable to ascertain whether it is possible to deduce the laws of the tides from short series of observations; since, if it be so, not only does the construction of good tide tables for different places become more easy; but also the value of tide tables is much increased, if the predicted tides agree with those of each year as well as with the mean of many years. The object of the author in the present paper is to determine this point by the discussion of several years' observations of the tides at Plymouth and at Bristol. The calculations for the former place were executed by Mr. Dessiou and Mr. Ross in the Hydrographer's Office at the Admiralty; the calculations for Bristol were performed by Mr. Bunt, in virtue of a grant of money from the British Association. The result of these discussions is, that a very regular form and good approximation for the semimenstrual inequality may be obtained from the observations of one year; that the existence of the lunar parallax corrections appears very clearly in the observations of one year; and that its value may be determined from a series of three or four years. The lunar declination corrections are more irregularly given by short series of observations; but in a series of four or five years, the general form and approximate value of the corrections become manifest. In the course of these calculations such questions as the following were proposed, and their solution attempted: 1. To which transit of the moon ought we to refer the tide? It appears that the transit which produces the best accordance with theory, is that which Mr. Lubbock terms transit B, which is an epoch about 42 hours anterior to the high water at Bristol and Plymouth. 2. How does a change of the epoch affect, first, the semimenstrual inequality; secondly, the parallax correction of the time; thirdly, the declination correction of the times; fourthly, the parallax correction of heights; and fifthly, the declination correction of the heights? 3. Does the parallax corrections of height vary as the parallax? 4. Does the parallax correction of time vary as the parallax? 5. Does the declination correction of the heights vary as the square of the declination? 6. Does the declination correction of time vary as the square of the declination? 7. Can the laws of the corrections be deduced from a single year? 8. Are there any regular differences between the corrections of successive years? 9. Do the corrections at different places agree in themselves? It does not appear that any change of the epoch will produce an accordance of the observed laws with the theory, some of the inequalities requiring one epoch for this purpose, and some requiring another. The inequalities in different years and different places are also compared.

Mr. Whewell remarks, that since it has now been shown that good tide tables may be obtained from short series of observations, his researches with regard to the determination of the lunar corrections may be concluded; and the proper mode of farther prosecuting the subject, would be to have tide observations at several stations, each observatory reducing its own observations, and thus constantly improving the tables, as is practised in other branches of Astronomy.

"Researches in Embryology." *First Series.* By Martin Barry, M.D., F.R.S.E., Fellow of the Royal College of Physicians in Edinburgh. Communicated by P. M. Roget, M.D., Sec. R.S.

This paper is divided into two parts. In the first part the author describes the origin and structure of the ovisac, a vesicle common to all vertebrated animals, but hitherto regarded as the inner membrane of the "folliculus Graafianus" in Mammalia, and by some authors denominated the "chorion" in other Vertebrata. He also describes the real nature of the "folliculus Graafianus," and its relation to the calyx of the Bird; the germinal vesicle and its contents, as being the most primitive portion of the ovum; the order of formation of the several other parts of the ovarian ovum; and the true chorion of Mammalia as being a structure superadded within the ovary.

In the second part the author describes a granulous tunic of the ovum of Mammalia not hitherto observed; the manner of origin of the "membrana granulosa" of authors; the different situations of the ovum in the Graafian vesicle at certain periods *ante coitum*, not hitherto observed; and certain structures by means of which the ovum is made to occupy these several situations.

The following are the principal facts made known by Dr. Barry in this memoir; but other facts are also mentioned, which he intends to make the subject of a future communication. In Mammalia and in Birds the germinal vesicle and its contents are those parts of the ovum which are first formed. The germinal vesicle at an early period is surrounded by peculiar granules, forming an envelope not hitherto described. The ovum of all vertebrated animals is contained in a vesicle (the "chorion" of some authors, found in Birds, Amphibia, and Fishes), which is essentially the same in structure wherever found, and which he thinks it desirable universally to denominate an *ovisac*. This vesicle is the "couche *interne*" of the Graafian vesicle, as described by Professor Baer. The Graafian vesicle of Mammalia is nothing more than an ovisac that has acquired a covering or tunic, susceptible of becoming highly vascular, which covering is the "couche *externe*" of the Graafian vesicle as described by Baer. The ovisac of Birds, Amphibia, and Fishes ("chorion" of some authors), acquires in like manner a covering or tunic, susceptible of becoming highly vascular; and by the union of the ovisac with this covering, there is constituted a structure analogous to the Graafian vesicle of Mammalia. The quantity of yelk in the former being large, that portion of the ovary which contains the structure here referred to (as analogous to the Graafian vesicle of Mammals) becomes pendent; and now the united coverings of the yelk-ball,—viz. the ovisac, its external tunic, the ovarian stroma, and the peritoneal investment,—are together called the *calyx*. From this it will be obvious that the Graafian vesicle is not a structure peculiar to Mammalia, as it has been supposed.

The ovisac has at first an elliptical or ellipsoidal form, becomes more spherical, and in Mammalia is often met with somewhat tapered at one end. The structure of the ovisac in some of the Mammalia may be examined when it does not exceed in length the 50th or even the 100th part of a Paris line, that is, in the latter case, the 1125th of an English inch. Myriads of ovisacs with their contents are formed that never reach maturity. Some of the ovisacs which do not reach maturity are situated in the parietes of Graafian vesicles in Mammalia, or of the corresponding structures in other Vertebrata; being sometimes formed in this situation, and sometimes included within the covering which the larger ovisac acquires. The minute ovisacs so situated the author proposes to denominate *parasitic* ovisacs. The ovisac is often found in a cavity proper to itself, with the walls of which it has no organic union. The granules forming the envelope of the germinal vesicle above referred to, and subsequently found in the fluid of the ovisac, are very peculiar in their appearance, contain a nucleus, and sometimes also a pellucid fluid, and are intimately connected with the evolution of the ovum. These granules are present in largest quantity in the ovisac of Mammalia; yet granules essentially the same exist in an early stage in the ovisac of Birds, and are sometimes met with in that of Fishes.

A continual disappearance of ova, and a formation of others, are observable even at a very early age. The ovum of Mammalia when completely formed is at first situated in the *centre* of the ovisac. It is at this period supported in the centre of the ovisac by an equable diffusion of granules throughout the fluid of the latter. The ovisac about the same time begins to acquire a covering or tunic, by which addition, as already stated, there is constituted a Graafian vesicle; and of the latter, the ovisac is now the inner membrane. After this period, then, it is proper to speak, not of an ovisac, but of a Graafian vesicle. The peculiar granules of the Graafian vesicle arrange themselves to form three structures, viz. the *membrana granulosa* of authors, and two structures not hitherto described, one of which the author proposes to name the *tunica granulosa*, and the other, which is rather an assemblage of structures than a single structure, the *retinacula*. The tunica granulosa is a spherical covering proper to the ovum, and its presence explains why the outer line in the double contour of the thick chorion has remained so long unobserved. At a certain period this tunic, in some animals at least, is seen to have tail-like appendages, consisting of granules similar to its own. The retinacula consist of a central mass containing the ovum in its tunica granulosa, and of cords or bands extending from this central mass to the membrana granulosa. These structures at a certain period became invested by a membrane. The offices of the retinacula appear to be,—first, to suspend the ovum in the fluid of the Graafian vesicle,—next, to convey it to a certain part of the periphery of this vesicle,—and subsequently to retain it in the latter situation, and also to promote its expulsion from the ovary. The particular part of the periphery of the Graafian vesicle to which the ovum is conveyed, is uniformly that directed towards the surface of the ovary. The mass of granules escaping with the ovum on the bursting of a Graafian vesicle under the compressor, is composed chiefly of the tunica granulosa and the ruptured retinacula. The "cumulus" of Professor Baer is made up of the parts called by Dr. Barry the tunica granulosa and the central portion of the retinacula; and the band-like portions, collectively, of what Dr. Barry calls the retinacula, mainly contribute to produce the appearance denominated the "flat disc" by Professor Baer.

In Mammalia a thick and highly transparent membrane,—the true chorion,—is formed external to the proper membrane of the yelk, while the latter is in the ovary. The inner part of the substance of the chorion in its early stages is in a fluid state, so that the yelk-ball moves freely in it; but it subsequently acquires more consistence. There is not any structure corresponding to the chorion in the *ovary* of other vertebrated animals.

The following appears to be the order of formation, as to time, of the more permanent parts of the ovum and the Graafian vesicle in Mammalia, viz.:

1. The germinal vesicle, with its contents, and its envelope of peculiar granules.
2. The proper membrane of the ovisac, which forms around this envelope of granules.
3. The yolk, which forms around the germinal vesicle.
4. The proper membrane of the yolk, which makes its appearance while the yolk is still in an incipient state.
5. The chorion.
6. The covering or tunic of the ovisac; and about the same time, the peculiar granules of the ovisac arrange themselves to form,
   - The tunica granulosa,
   - The retinacula, and
   - The membrana granulosa.

Such of these structures as are present in the ovary of other Vertebrata, appear to originate in the same order as to time.

"Contributions to the Physiology of Vision." By Charles Wheatstone, Esq., F.R.S., Professor of Experimental Philosophy in King's College, London. *Part the First.* "On some remarkable and hitherto unobserved Phenomena of Binocular Vision."

The author first shows that the perspective projections of an object upon the two retinæ differ according to the distance at which the object is placed before the eyes; if it be placed so distant that to view it the optic axes must be parallel, the two projections are precisely similar; but if it be placed so near that to regard it the optic axes must converge, a different perspective projection is presented to each eye; and these perspectives become more dissimilar as the convergence of the optic axes becomes greater. Notwithstanding this dissimilarity between the two pictures, which is in some cases very great, the object is still seen single; contrary to the very prevalent metaphysical opinion, that the single appearance of objects seen by both eyes is owing to their pictures falling on corresponding points of the two retinæ. After establishing these principles, the author proceeds to ascertain what would result from presenting the two monocular perspectives, drawn on plane surfaces, to the two eyes, so that they shall fall on the same parts of the two retinæ as the projections from the object itself would have fallen. Several means are described by which this may be accomplished; but the author especially recommends for this purpose an apparatus called by him a *stereoscope*, which enables the observer to view the resulting appearances without altering the ordinary adaptation of the eyes, and therefore without subjecting these organs to any strain or fatigue. It consists of two plane mirrors with their backs inclined to each other at an angle of 90°, near the faces of which the two monocular pictures are so placed that their reflected images are seen by the two eyes, one placed before each mirror, in the same place; the apparatus has various adjustments by means of which the magnitude of the images on the retinæ may be varied, and the optic axes differently converged. If the two monocular pictures be thus presented one to each eye, the mind will perceive, from their combined effect, a figure of three dimensions, the exact counterpart of the object from which the pictures were drawn; to show that this curious illusion does not in the least depend on shading or colouring, the illustrations principally employed are simple outline figures, which give for their perceived resultants skeleton forms of three dimensions. Each monocular outline figure is the representation of two dissimilar skeleton forms, one being the form which it is intended to represent, and another, which Prof. Wheatstone calls its converse figure Viewed by one eye alone the outline may with equal ease be imagined to be either; but when the two monocular pictures are viewed one by each eye, the proper or the complemental form may be fixed in the mind; the former, if the right and left pictures be presented respectively to the right and left eyes; and the latter, if the right picture be presented to the left eye, and the left picture to the right eye. Many new experiments are then detailed, and a variety of instances of false perception of visual objects, some new, others formerly observed, are traced to these principles; among others, the well-known apparent conversion of cameos into intaglios. The author next proceeds to show that pictures similar in form but differing in magnitude within certain limits, when presented one to each eye, are perceived by the mind to be single and of intermediate size; and also that when totally dissimilar pictures, which cannot be combined by the mind into the resemblance of any accustomed objects, are presented one to each eye, they are in general not seen together, but alternately. The memoir concludes with a review of the various hypotheses which have been advanced to account for our seeing objects single with two eyes; and the author states his views respecting the influence which these newly developed facts are calculated to have on the decision of this much debated question.

"Experimental Researches in Electricity," *Fourteenth Series. On the general nature and relation of the Electric and Magnetic Forces.* By Michael Faraday, Esq., D.C.L., F.R.S., &c. &c.

The author commences by observing that the theory of electrical induction, which he had set forth in the 11th, 12th, and 13th series of researches, does not assume or decide anything as to the real nature of the electric forces, but only as to their distribution; the great question respecting the existence of any electric fluid, or of one, or of two fluids remaining untouched. He then states what the theory does assume; as, for instance, that all *particles*, whether of insulators or conductors, are, as *wholes*, conductors; that, being conductors, they can readily be charged either bodily or polarly; that contiguous particles being on the line of inductive action can communicate their forces more or less readily; that those doing so most readily constitute the bodies called *conductors*, and those doing so least readily those called *insulators*, &c.

Having thus given a brief summary of the conclusions drawn from the previous investigations, the author proceeds to consider the particular condition of the particles which, in an insulating body, are considered as polarized; and after showing that the theory requires that they should be able to polarize in any direction, he states his expectation that a greater facility to polarize in one direction than another would still be found to belong to them, and proceeds experimentally to determine this point. His experiments were made by observing the degree of inductive force across cubes of perfectly crystallized bodies, as rock crystal and Iceland spar; these being cut so as to have the axis of the crystal parallel to the line joining two opposite faces of the cube; but the experiments, which are laborious, require extension, and he has not as yet been able to prove or disprove the expected result.

The author then considers whether in compound bodies it is the ultimate and elementary particles or the compound particles which polarize as wholes. He concludes that it is the latter which assume that state; and shows how this point bears upon the electrolyzation of such bodies as are separated into simpler substances, or otherwise altered by the action of the voltaic current.

He then proceeds to certain experiments bearing upon the nature of the relation of the electric and magnetic forces, giving his view of the character of this relation; and concludes his paper by briefly stating what he thinks is more satisfactorily explained by the theory which refers inductive action to an action of contiguous particles than by the old theory.

"Experiments on the Vibration of the Pendulum." By W. J. Frodsham. Communicated by Francis Beaufort, Capt. R.N., F.R.S.

The object of this paper is to show the advantages that may result from attaching to the top of the pendulum a brass tube, which the author terms "an isochronal piece," about five inches in length, fitting the pendulum very nicely, and slit so as to form a spring for about an inch at the bottom, sliding rather stiffly on the rod, so that its position, and consequently its influence on the action of the pendulum, may be varied at pleasure; and that unequal arcs of vibration may be made to correspond to equal intervals of time.

"An Account of some Experiments on the Blood in connexion with the Theory of Respiration." By John Davy, M.D., F.R.S., Assistant Inspector of Army Hospitals.

The author has investigated, experimentally, several of the important questions connected with the theory of respiration and of animal heat; and arrives at the following results. He finds that the blood is capable of absorbing oxygen both from atmospheric air, and from oxygen gas, independently of putrefaction. After blood has been agitated in common air, a trace of carbonic acid, not exceeding one per cent., is found in the residual air; but when pure oxygen is employed, no carbonic acid can be detected in it by the most carefully conducted trials. When pure carbonic acid is brought into contact with blood, or serum, over mercury, and moderately agitated, the absorption of gas exceeds the volume of the fluid. Both arterial and venous blood are rendered very dark, and serum more liquid by the absorption of this gas to saturation. Serum, in its healthy state, is incapable of absorbing oxygen, or of immediately furnishing carbon to form carbonic acid: and after it has absorbed carbonic acid, only one-tenth of the absorbed gas is expelled by successive agitation with atmospheric air, or with hydrogen. The author is inclined to think that the alkali in the blood, in its healthiest condition, is in the state of a sesquicarbonate. In the majority of trials manifest indications of the disengagement of air from blood *in vacuo* were obtained: but as it occasionally happened that no air could be thus extricated, the author is induced to believe that the quantity of air contained in the blood is variable: and he has found this air to consist solely of carbonic acid gas. It would also appear, from the experiments detailed in this paper, that a portion of oxygen exists in the blood, not capable of being extracted by the air-pump, yet capable of entering into combination with nitrous gas; and existing in largest proportion in arterial blood. The absorption of oxygen by blood is attended with an increase of temperature.

The experiments of the author tend to show that the lungs are absorbing and secreting, and perhaps also inhaling organs, and that their peculiar function is to introduce oxygen into the blood and separate carbonic acid from the blood: and they favour the idea that animal heat is owing, first, to the fixation or condensation of oxygen in the blood in the lungs during its conversion from venous to arterial; and secondly, to the combinations into which it enters in the circulation in connexion with the different secretions and changes essential to animal life.

"On the Geometrical Forms of Turbinated and Discoid Shells." By the Rev. H. Moseley, Professor of Natural Philosophy and Astronomy in King's College, London. Communicated by Thomas Bell, Esq., F.R.S.

This paper is occupied by an investigation of certain mathematical principles which the author considers as governing the formation of turbinated and discoid shells. According to these views, all such shells may be conceived to be generated by the revolution about a fixed axis of the perimeter of a geometrical figure, which, remaining always similar to itself, increases continually its dimensions. The spiral lines which are observable on the opercula of certain classes of shells, taken in connexion with the well-known properties of the logarithmic or equiangular spiral, appear to have suggested the idea, that not only the boundary of the operculum, which measures the sectional expansion of a shell, but also the spiral lines, which in general are well marked both externally and internally in the shell itself, are curves of this nature.

From an examination of the spirals marked on opercula, it appears that the increase of their substance takes place on one margin only; the other margin still retaining the spiral form, and acquiring an increase of length by successive additions in the direction of the curve. As in the logarithmic spiral the distances of successive spires, measured on the same radius vector produced from the pole, from each other, are respectively in geometrical progression, if similar distances between the successive whorls on the opercula of shells be found to observe the same law, it will follow that these whorls must have a similar form; and that such is the case, the author shows by a variety of numerical results obtained by careful measurements on three different opercula of shells of the order *Turbo*. That such is the law of nature in the formation of this class of shells is rendered probable by the instances adduced by the author, in which a conformity to this law is found to exist.

From the known properties of the logarithmic spiral the author concludes that the law of the geometrical description of turbinated shells is, that they are generated by the revolution about a fixed axis, (namely, the axis of the shell,) of a curve, which continually varies its dimensions according to the law, that each linear increment shall vary as the existing dimensions of the line of which it is the increment. If such be the law of nature, the whorls of the shell, as well as the spires on the operculum, must have the form of the logarithmic spiral; and that this is likewise the case is shown by the almost perfect accordance of numerical results, deduced from the property of that curve, with those deduced from a great variety of careful measurements made of the distances between successive whorls on radii vectores drawn on shells of the *Turbo duplicatus*, *Turbo phasianus*, *Buccinum subulatum*, and in a fine section of a *Nautilus pompilius*. The author further states that, besides the results given in the paper, a great number of measurements were similarly made upon other shells of the genera *Trochus*, *Strombus*, and *Murex*, all confirmatory of the law in question.

One of the interesting deductions which the author has derived from the prevalence of this law in the generation of the shells of a large class of mollusca, is that a distinction may be expected to arise with regard to the growth of land and of aquatic shells, the latter serving both as a habitation and as a float to the animal which forms it; and that, although the facility of varying its position at every period of its growth may remain the same, it is necessary that the enlargement of the capacity of the float should bear a constant ratio to the corresponding increment of its body; a ratio which always assigns a greater amount to the increment of the capacity of the shell than to the corresponding increment of the bulk of the animal.

Another conclusion deducible from the law of formation here considered is, that the growth of the animal, corresponding to a given increment in the angle of the generating curve, will always be proportional to the bulk it has then attained: and if the physical vital energies of the animal be proportional to its actual bulk, its growth, in any given time, will be proportional to its growth up to that time. Hence the whole angle of revolution of the curve generating the shell will be proportional to the whole corresponding time of the animal's growth; and therefore, the whole number of whorls and parts of whorls will, at any period, be proportional to its age.

The form of the molluscous animal remaining always similar to itself, the surface of the organ by which it deposits its shell will vary as the square of the linear dimensions; but as the deposition of its shell must vary as the cube of the same dimensions, there must be an increased functional activity of the organ, varying as the simple linear dimensions.

Since to each species of shell there must correspond a particular number expressing the ratio of the geometrical progression of the similar successive linear dimensions of the whorls; and since the constant angle of the particular logarithmic spiral, which is affected by that species of shell, is deducible from this number, the author considers that, connected as the form of the shell is with the circumstances of the animal's growth and the manner of its existence, this number, or the angle of the particular spiral, determinable as it is in each case by actual measurement, may be available for the purposes of classification, and may suggest relations by which, eventually, they may become linked with characteristic forms, and modes of molluscous existence.

The concluding portion of the paper contains a mathematical discussion of certain geometrical and mechanical elements of a conchoidal surface. These are, the extent of the surface itself; the volume contained by it; the centre of gravity of the surface, and also of the volume, in each case, when the generating figure revolves about a fixed axis without any other motion, and also when it has, besides this, a motion of translation in the direction of that axis; and, lastly, the angle of the spiral. The author states that his object in this inquiry is the application of these elements to a discussion of the hydraulic theory of shells. The constant angle of the spiral, which each particular species affects, being connected by a necessary relation with the economy of the material of the habitation of each, with its stability, and the condition of its buoyancy, it is therefore necessary to determine the value of this angle.

"On the relative attractions of Sulphuric Acid for water, under particular circumstances: with suggestions of means of improving the ordinary process of manufacturing Sulphuric Acid." By Henry Hugh Watson, Esq., Corresponding Member of the Manchester Philosophical Society. Communicated by John Dalton, D.C.L., F.R.S., &c.

The object of the inquiry detailed in the present paper is to determine at what degree of concentration the affinity of sulphuric acid for aqueous vapour is equal to that of anhydrous space for the same vapour at given temperatures. It has long been known that concentrated sulphuric acid abstracts moisture from the atmosphere, but the amount and the rate of this absorption have never been ascertained with accuracy; and consequently, in applying this acid to purposes of exsiccation, the experimenter has often been at a loss to know whether the acid was sufficiently strong to render the space in which it was confined perfectly anhydrous. By placing portions of the acid, previously weighed, and diluted with known quantities of water, under the receiver of an air-pump, with equal portions of concentrated acid, of the specific gravity 1·8428, in similar dishes, the author ascertained that the dilute acid could be concentrated to the specific gravity 1·814, at a temperature varying from 65° to 57°: whence he concludes that acid of such strength is capable of drying a vacuum when the temperature does not exceed 57°. By making similar experiments in air, the author compared together the weights lost by ten grains of dilute sulphuric acid of the specific gravity 1·135, at three different periods of the day for six days, taking note of the dew-point and the temperature; and infers that when the affinity of space for vapour, or the evaporating force, is equal to 0·15 of an inch of mercury, it is just able to balance the affinity for water of sulphuric acid of the specific gravity 1·249.

The author next instituted a series of experiments to ascertain whether the evaporation of water from dilute sulphuric acid is capable of being carried on to the same extent in air as in vacuo, and found that the evaporating force of air exerted upon such acid is less than that of a vacuum at the same temperature. He observes that his experiments offer conclusive evidence that the evaporation of water is not owing to the existence of a chemical affinity between the vapour of the liquid and atmospheric air; but thinks that they favour the notion that the obstruction to this process in the open atmosphere is rather owing to the pressure than to the *vis inertiæ* of the particles of air. He is also of opinion that improvements will hereafter arise from this inquiry with regard to the economical management of the process of manufacturing sulphuric acid, which process would be greatly expedited by the regulated admission of steam into the condensing chambers kept at a constant high temperature.

The Society then adjourned over the long vacation to meet again on the 15th of November next.